

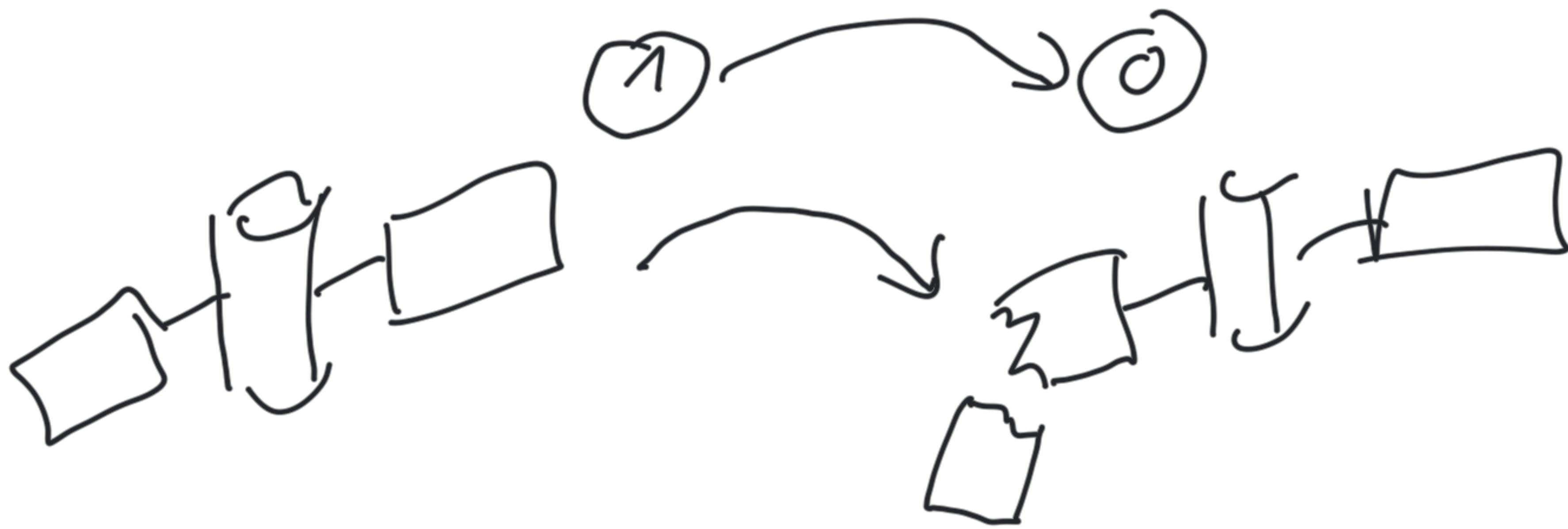


$T \sim \text{Exp}(\lambda)$

$$\lambda = 0.005$$

$$f(x) = \lambda e^{-\lambda x}$$

$$F(x) = 1 - e^{-\lambda x}$$



$$P(n) = \begin{bmatrix} 1 & 0 \\ 0.005 & 0.995 \end{bmatrix} P_{10}(1) = 0.005$$

$$P_{10}(10) \approx 0.049 \quad P_{10}(2) = 0.0059$$



$$P_{10}(t) = 1 - e^{-\lambda t}$$

$$P(t) = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\begin{aligned}
 & P(T > t + dt \mid T > t) \\
 &= \frac{1 - F(t + dt)}{1 - F(t)} = \frac{1 - F(t)}{1 - F(t + dt)} \\
 &= \frac{1 - (1 - e^{-\lambda(t+dt)})}{e^{-\lambda t} - \cancel{\lambda dt}} = \frac{e^{-\lambda t} - (1 - e^{-\lambda t})}{e^{-\lambda t}} = \frac{e^{-\lambda t}}{e^{-\lambda t}} = 1 - F(dt) \\
 &\therefore P(T > dt)
 \end{aligned}$$

$$P(T > t + dt \mid T > t) \\ = \frac{P(T > t + dt, T > t)}{P(T > t)}$$

Can be left out, is included

$T > t + dt$  implies that  $T > t$

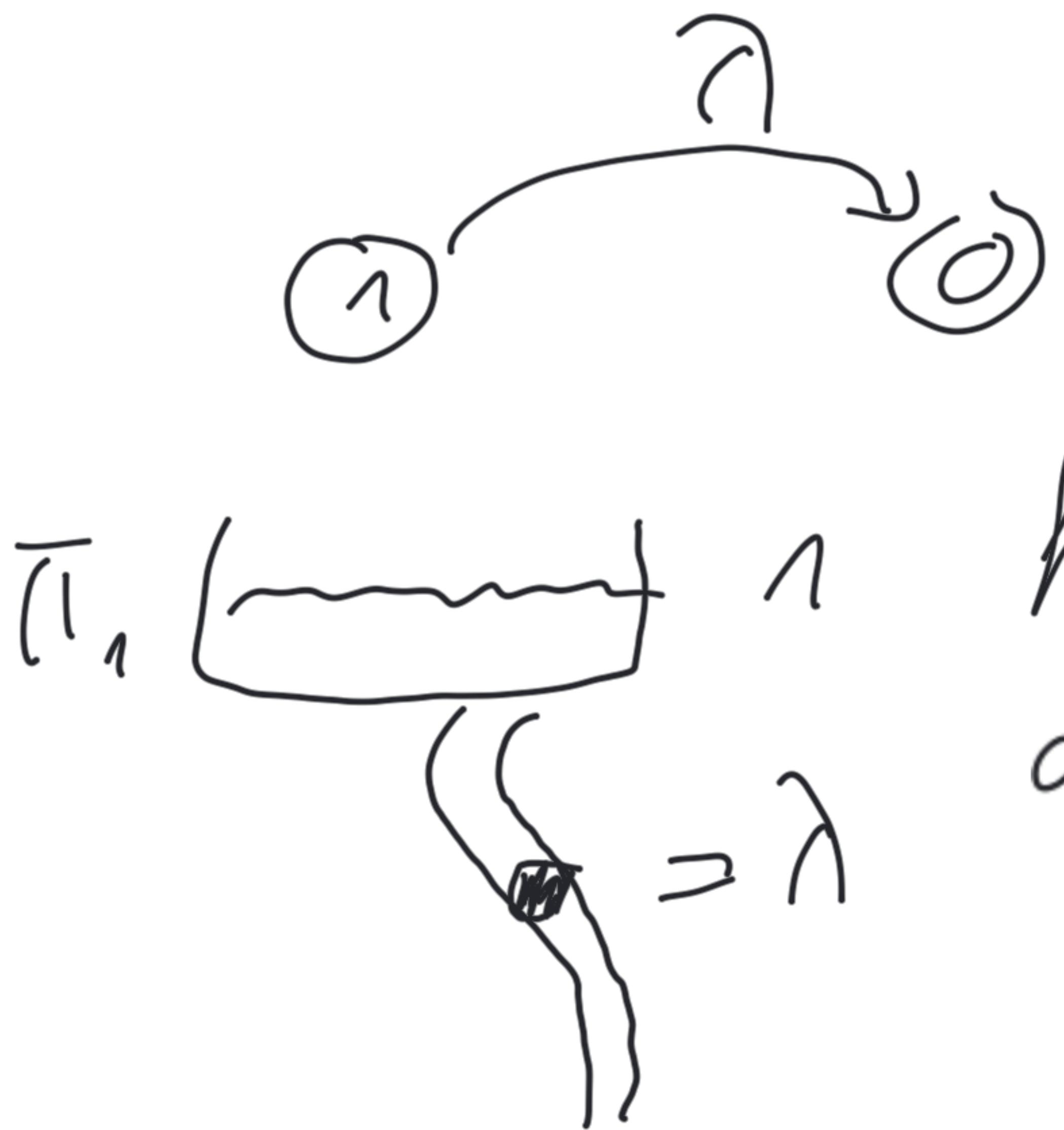
Therefore  $P(T > t + dt, T > t) = P(T > t + dt)$

$$\frac{\text{prob}}{\text{time}} = \text{rate} \quad P_{10}(t)$$

$$\frac{P_{10}(1)}{1} \approx 0.005 \quad \lim_{t \rightarrow 0} \frac{P_{10}(t)}{t} = g_{10}$$

$$\frac{P_{20}(2)}{2} \approx 0.005$$

$$\frac{P_{10}(10)}{10} \approx 0.005$$



$$\dot{\pi}_0 = \text{rate} \times \bar{\pi}_1$$

$$\frac{d\pi_1}{dt} = -\text{rate} \cdot \bar{\pi}_1 - \lambda \cdot \pi_1$$

$$\bar{\pi}_0 = 0 \quad \frac{d\bar{\pi}_0}{dt} = \lambda \cdot \pi_1$$



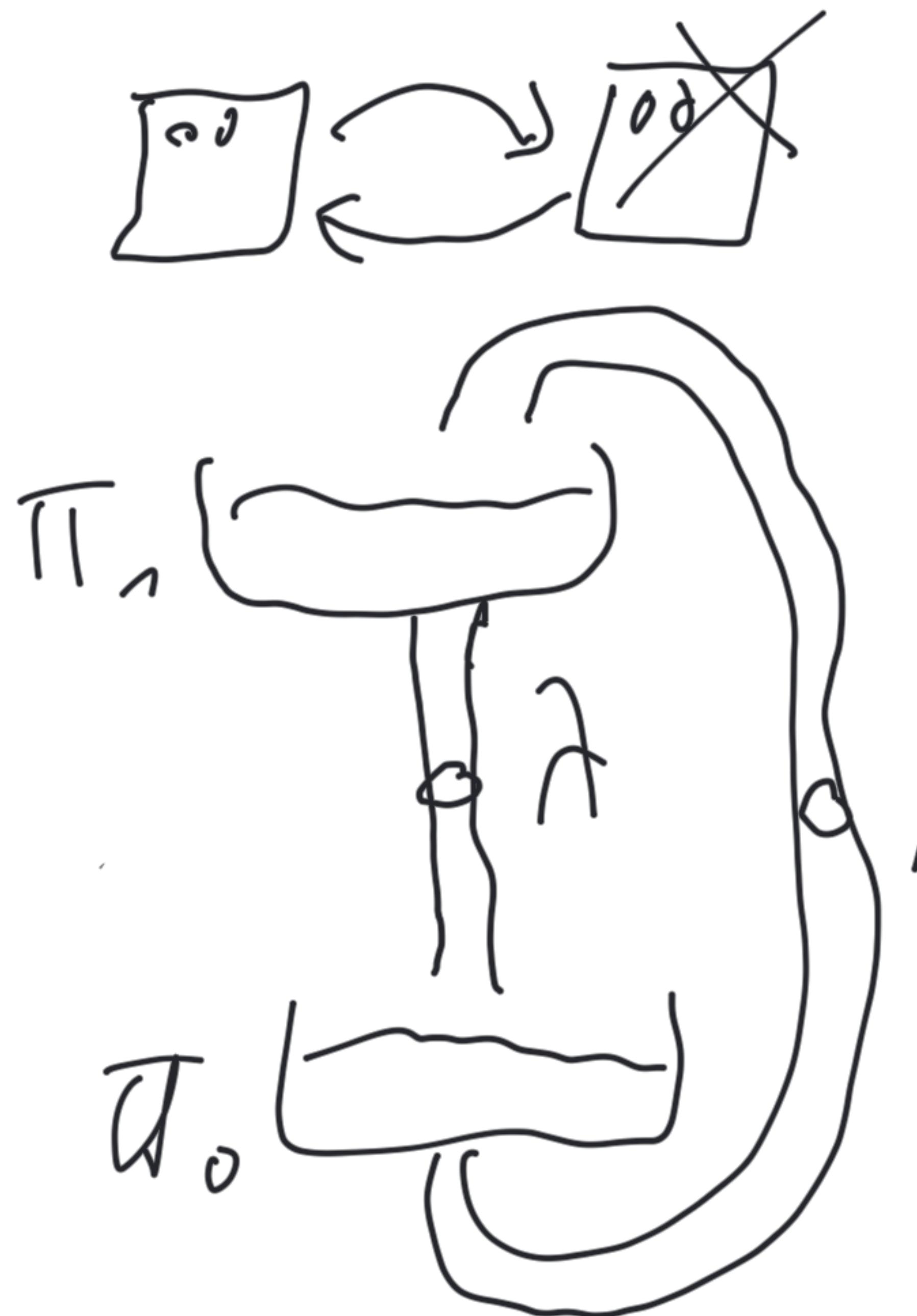


$$\begin{aligned} \text{TTF} &\sim \text{Exp}(\lambda) \\ \text{TRR} &\sim \text{Exp}(\mu) \end{aligned}$$

$$Q = \begin{bmatrix} -\mu & \mu \\ \lambda & -\lambda \end{bmatrix} \quad \begin{aligned} g_{10} &= \lambda \\ g_{01} &= \mu \end{aligned}$$

infinitesimal generator matrix

$$\Pi = (\Pi_0, \Pi_1)$$



$$\overline{\text{TR}} \sim \text{Exp}(\lambda)$$

$$\overline{\text{TR}} \sim \text{Exp}(\mu)$$

$$\mu \frac{d\overline{\text{TR}}_1}{ds} = -\lambda \overline{\text{Pi}}_1 + \overline{\text{Pi}}_0 \mu$$

$$\frac{d\overline{\text{Pi}}_0}{dt} = \lambda \overline{\text{Pi}}_1 - \mu \overline{\text{Pi}}_0$$

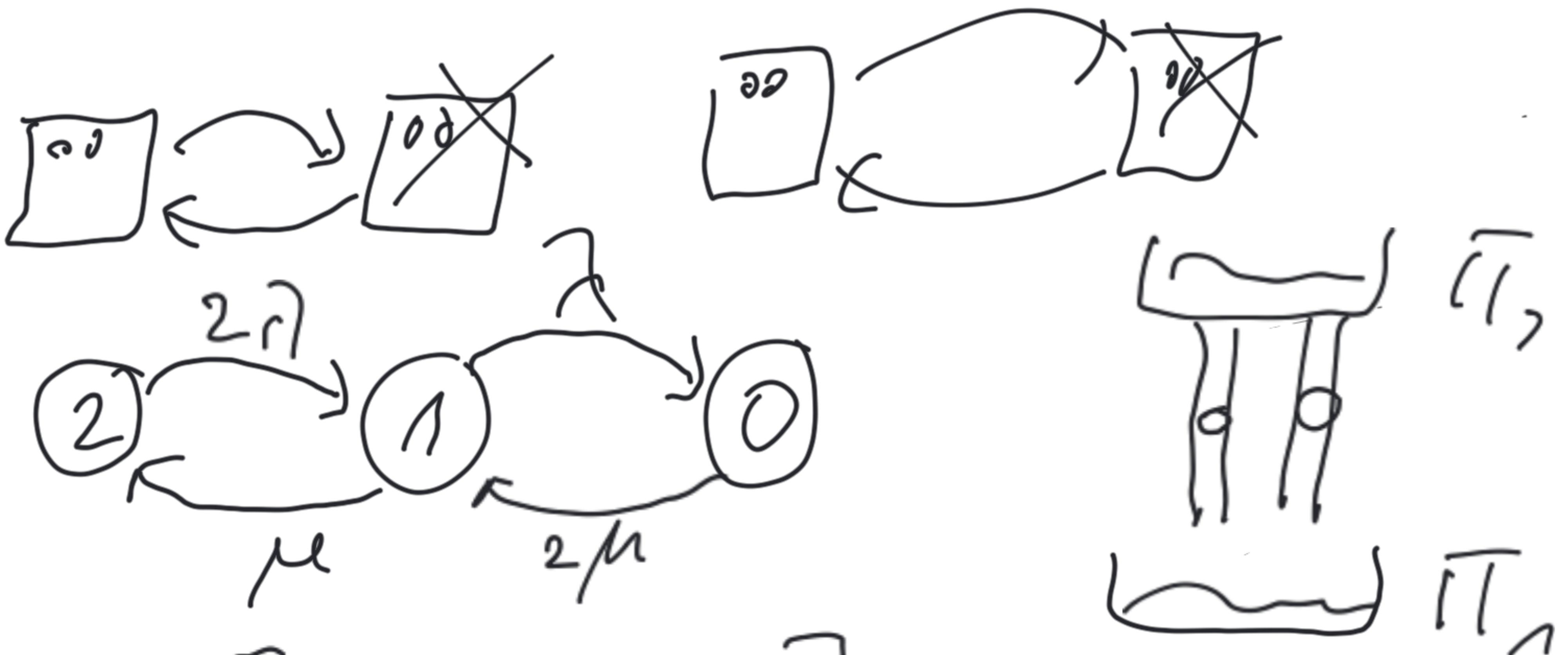


$$\frac{d\bar{\pi}_1}{dt} = \mu \cdot \bar{\pi}_0 - \lambda \cdot \bar{\pi}_1 \quad \left| \frac{d\bar{\pi}}{dt} = \bar{\pi} \cdot Q \right.$$

$$\frac{d\bar{\pi}_i}{dt} = \text{In} - \text{Out} \quad \left| \begin{array}{l} = 0 \\ \text{In} = \text{Out} \end{array} \right.$$

$$= \sum_{j \neq i} \bar{\pi}_j q_{ji} - \sum_{i \neq j} \bar{\pi}_i q_{ij}$$

$$= \sum \bar{\pi}_j q_{ij} \quad \downarrow -q_{ii}$$



$$Q = \begin{bmatrix} -2\mu & 2\mu & 0 \\ \lambda & -\lambda\mu & \mu \\ 0 & 2\lambda & -2\lambda \end{bmatrix}$$

$$P(T_1 > t \wedge T_2 > t) \sim \text{Exp}(\lambda)$$

$$= (1 - F(t)) \cdot (1 - F(t))$$

$$= (1 - e^{-\lambda t})^2 (1 - e^{-\lambda t})$$

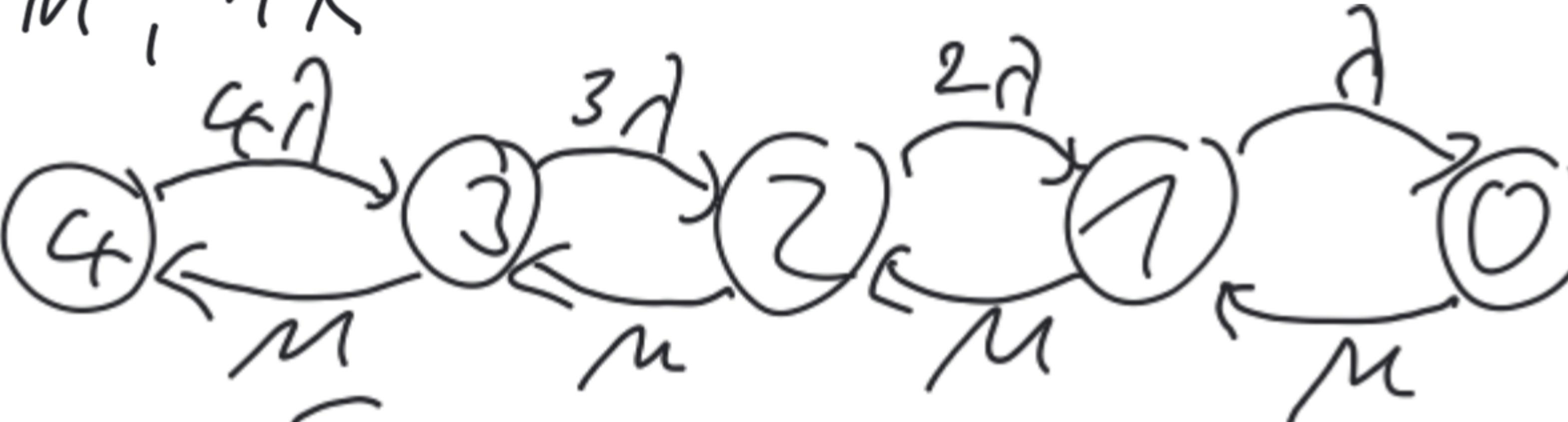
$$= e^{-2\lambda t} \cdot e^{-\lambda t}$$

$$= e^{-3\lambda t}$$

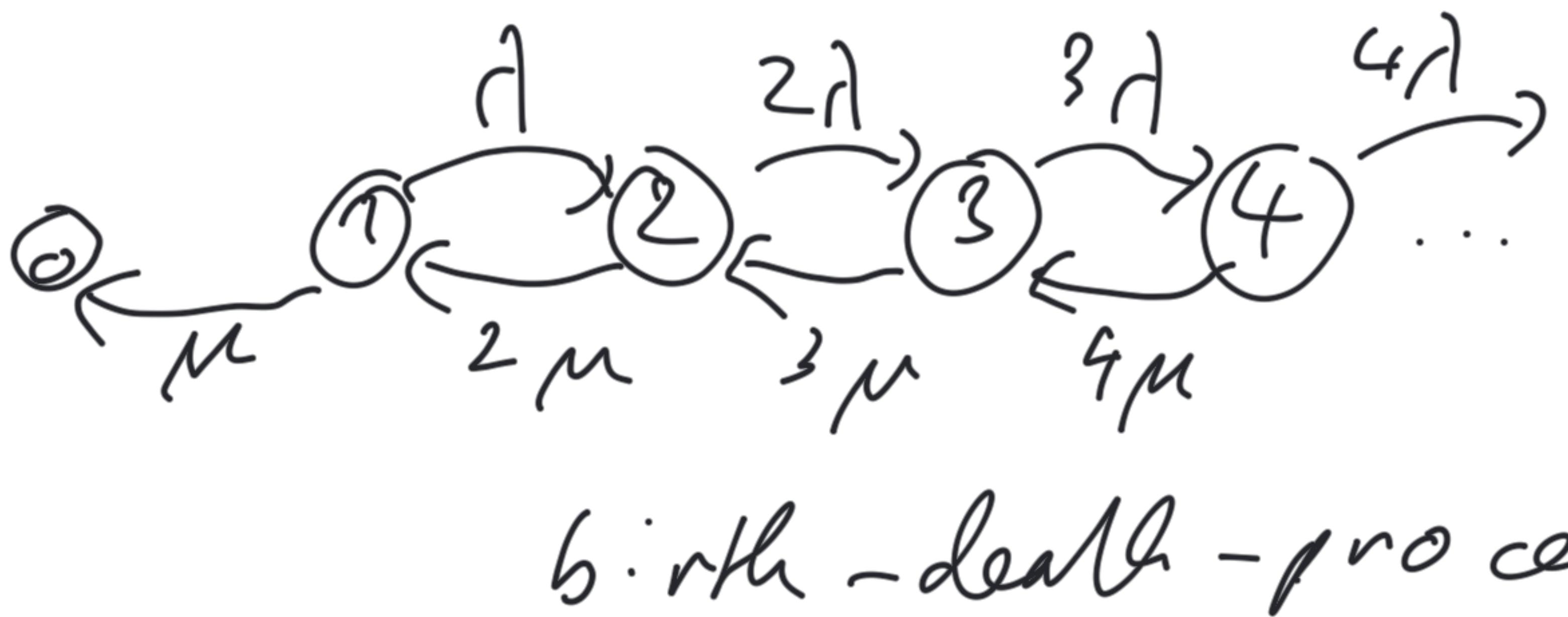
$$= 1 - F(t)$$

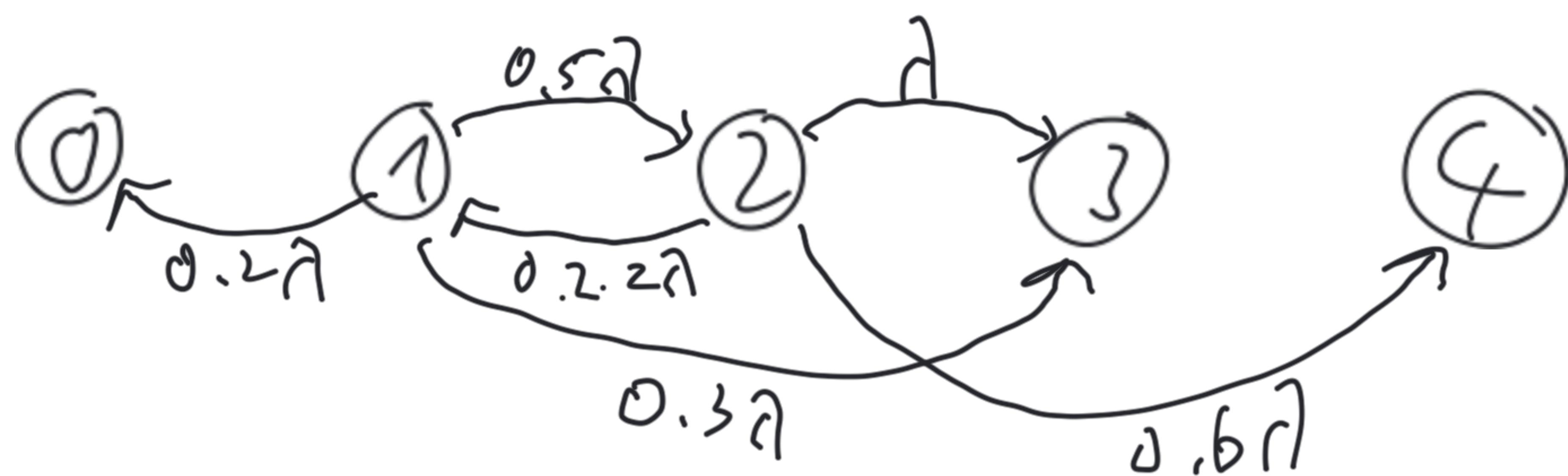
$$F(t) = 1 - e^{-3\lambda t}$$

$4M, 1R$



$$Q = \begin{bmatrix} -\mu & \mu & 0 & 0 & 0 \\ \lambda & -\lambda - \mu & \mu & 0 & 0 \\ 0 & 2\lambda & 2\lambda - \mu & \mu & 0 \\ 0 & 0 & 3\lambda & -3\lambda - \mu & \mu \\ 0 & 0 & 0 & 4\lambda & -4\lambda \end{bmatrix}$$





$$\frac{d\bar{\pi}}{dt} = \bar{\pi}Q$$

$$\bar{\pi}Q = 0 \rightarrow \bar{\pi}P = \bar{\pi}$$

$$Q \xrightarrow{\Delta} P$$

$$\Delta < \frac{1}{\max\{q_{ii}\}}$$

$$P = I + \Delta \cdot Q$$